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that in each advanced educational institution there be a committee on research to promote original investigations on the part of the faculty and graduate students.

5. To establish research fellowships in educational institutions, thus affording qualified workers an opportunity to devote themselves entirely to research work.

6. To secure wherever possible endowments for research purposes.

It is evident that so far from being primarily work in the practical application of what we know already, the enterprise is intended to be primarily a stimulus to fundamental research in every direction. It is not *practical application* that is to be stimulated chiefly, but *exploration*, which may or may not result in practical application. It is felt, for example, that the more we know about the structures and activities of plants, the better equipped we shall be to handle plants intelligently. Our botanical program, therefore, is simply to extend the boundaries of our knowledge of plants as far as possible. In pursuance of this program, at least two things are felt to be necessary.

In the first place, there must be developed some scheme of cooperation among our botanical establishments; and notably between the research establishments and the so-called practical establishments. For example, we recognize in general three great botanical agencies at work to-day, working independently, and in too great ignorance of each other's results. These agencies are the Department of Agriculture, the agricultural colleges and experiment stations, and the universities. All of these agencies are investigating plants from various points of view, but they are not as mutually helpful, or even as mutually stimulating as they should be in the interest of progress. I have met many cases of men intellectually equipped to work, but with no adequate material or equipment; and also even more cases of fine equipment and

abundant material, and no man trained to use them effectively. In other words, the distribution of men and equipment is not as effective as it should be.

In the second place, there must be developed some plan of supporting research wherever there is a competent investigator. The movement to establish research fellowships has begun already, and as the value of research becomes better understood, there is no reason to doubt that every botanical explorer will have the opportunity to explore. There is at present a tremendous amount of waste in the investigations produced by the universities. Every year scores of young investigators, well equipped to continue exploration, are automatically side-tracked by a degree, and forced into positions where investigation is killed, or at least becomes anemic. The council proposes to conserve some of this investigative ability, and to give it a chance to express itself. In short, the opportunity now presented to us is to increase the opportunities for botanical research to such an extent by cooperation and conservation of investigative ability that the progress of botany should take on a greatly increased momentum. And all this can be done if at this psychological moment we as botanists can make it clear that a fundamental knowledge of plants is a great national asset.

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THE COMMITTEE OF ONE HUNDRED
ON SCIENTIFIC RESEARCH OF THE
AMERICAN ASSOCIATION FOR
THE ADVANCEMENT OF
SCIENCE

REPORT OF THE SUBCOMMITTEE ON
ENGINEERING

In view of the fact that a subcommittee on engineering has only very recently been appointed by the American Association for the Advancement of Science committee of one

hundred on scientific research, no report concerning actions or accomplishment can be submitted at this time. A few suggestions may be offered, however, bearing upon the activities of an engineering research committee.

Researches in engineering may be divided into two classes; namely (1) those undertaken for the assistance of some particular industry or manufacture, and (2) those undertaken for the advancement of technical knowledge or applied science. Industrial researches are numerous, and have a great history; but very little literature. They also have a great range of character and intensiveness, say from overcoming, in a few minutes, certain little mechanical difficulties in the behavior of a machine, to scientific investigations pursued systematically for years, perhaps with a staff of trained technicians, say for the purpose of developing some important industrial process. The amount of industrial research going on in the country is, in the aggregate, very great, and is likely to increase as time goes on and industries further specialize. Many of these problems of industrial research fall within the professional province of consulting engineering, and indeed few new large engineering undertakings can be met without involving some new industrial research. The characteristic quality of industrial research is that it does not find direct or immediate publication. Probably much of it is eventually published either in the form of engineering data or in patent specifications; but the competition between branches of industry almost inevitably demands that the scientific or technical underlying progress should be protected. The industrial value of successful researches may be so great that their nondisclosure is a first consideration in reward of the necessary labor and expense. The hope and justification of industrial research is that it may, and often does, pay for itself. In many instances it has paid most handsomely.

On the other hand, the second type of research, *i. e.*, engineering researches or researches for engineering development may also cover a great range of quality and inten-

siveness from say brief tests of the performance of some machine, to elaborate investigations in mathematics, physics, chemistry or economics. Such engineering researches may either be intensely practical on the one hand; or they may be outside of the immediate fields of scientific application, and differ in no evident way from so-called pure scientific enquiry, paving and prospecting the ways for future use in engineering. The characteristic quality of these engineering researches is that in-so-far as they are successful they tend to find direct and immediate publication, and so to become available for the use of all concerned.

It is evident that engineering technological researches may be of great value to a country or to industries; but that they inherently lack self-support. Any laboratory engaged in researches, the successful results of which are to be published, can only expect to be supported either by national institutions, by gifts, or by benevolent endowment. For this reason, although industrial researches are numerous and widespread, engineering researches are mainly restricted to universities, technical colleges and government laboratories.

It would seem to be desirable that the laboratories in which engineering researches are carried on should all be brought into some cooperative association, not only for mutual benefit, but also for the benefit of engineering, and of the country at large, through engineering. It is desirable that each and every technological laboratory should develop a specialty or a group of specialties. The tendency in the past has been for essentially the same course of engineering studies to be pursued in the technical colleges, and in natural conformity therewith, the laboratory investigations have been more or less of the same type. In order, therefore, to develop greater advantages from cooperative effort, such specialties as happen to develop in the researches of technological laboratories should be fostered and encouraged, so long as freedom of individual action is not restricted.

The encouragement of specializing in engineering researches, for the greater good of

the country and of the world, can be effected by the Association for the Advancement of Science through the recognition of such specialization as spontaneously occurs, through grants for the solution of particular problems, and through assistance in finding adequate publication for the results that may be obtained from engineering researches.

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REPORT OF THE SUBCOMMITTEE ON PATHOLOGY

THE Committee on Research in Pathology recommends:

1. *Nature of Work to Be Aided.*—In the awarding of grants that preference be given to problems of etiology, immunity, functional pathology and chemical pathology, as representing the most profitable lines of investigation at present.

2. *Laboratories or Individuals to Be Aided.*—It is believed advisable to give grants preferably to laboratories presided over by a director of known training and ability in investigation, the funds of which are insufficient to meet the needs for special studies. This does not necessarily rule out an exceptional man in a laboratory indifferently manned, but it must be remembered, as a general proposition, that laboratories which need the money most are, on account of poor equipment and the lack of adequate staff, least prepared to use it to advantage. The best policy is to give where most can be accomplished and not where money is most needed.

It is undesirable to give money solely to encourage research in a general way by younger men under direction of the laboratory head. The aid should be for a definite problem of recognized importance and should be preferably to men of wide experience as investigators, and as far as possible to heads of departments, who will take an active part in the work, aided perhaps by their assistants.

In addition to departments of pathology, those of bacteriology, protozoology and immunology, or clinical medicine possessing well-equipped laboratories for investigation along any of the lines before mentioned shall be

considered as conducting research in pathology and eligible for grants. The sole conditions for the award of a grant should be (1) The formulation of a suitable problem; (2) the proposal of definite methods for its solution; (3) the possession of facilities adequate for the successful prosecution of the projected investigation.

3. *Amount of Grants.*—In view of the position taken in Section 2 it is recommended that grants of relatively large sums (several hundred dollars) be given to a few laboratories rather than smaller sums scattered more widely. These larger sums would ensure, presumably, an adequate return and would offer a greater incentive to concentrated work on important problems.

4. *Cooperation.*—It is considered desirable for the committee to keep in touch with other organizations, as the Rockefeller Institute for Medical Research and the Research Committee of the American Medical Association, offering grants for research in medicine in order (a) to avoid duplication of grants, (b) to exchange lists of applicants, (c) to profit by the experience of these organizations.

5. *Publicity.*—It is considered inadvisable to issue a general request for applications. The publication in *SCIENCE* and the *Journal of the American Medical Association* of the report of the committee should place the matter before the proper audience and lead to requests from individuals, presumably heads of departments most interested in such aid and best prepared to take advantage of it.

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REPORT OF THE SUBCOMMITTEE ON MATHEMATICS

IN view of the proposed plan to form research committees with the direct cooperation of various scientific organizations, the